



# Connect a School, Connect a Community Toolkit

M o d u l e 2

Disseminating Low-Cost Computing  
Devices in Schools

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Executive Summary

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# **CONNECT A SCHOOL, CONNECT A COMMUNITY TOOLKIT**

*Module on Disseminating  
Low-Cost Computing Devices  
in Schools*

## **Executive Summary**

May 2010

The full *Module on Low Cost Computing Devices for Schools*, available at [www.connectaschool.org](http://www.connectaschool.org), was prepared by a team, led by the Special Initiatives Division of the ITU Telecommunication Development Bureau. The team included author Janet Hernandez and web-editor John Alden (experts). The views expressed in the module, however, are those of the experts and do not necessarily reflect the opinions of ITU or its members.

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### 1 INTRODUCTION

A growing number of governments around the world are investigating and implementing low-cost computing device (LCCD) pilots or programs for schools in their countries. The potential LCCD market is vast. According to Intel Corporation, "There are 1.3 billion school-age children around the world, and of those, only five per cent have access to a PC..."<sup>1</sup> This report examines the LCCD arena, analyzes costs, identifies implementation issues and reviews different countries experiences with LCCD programs.

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<sup>1</sup> <http://www.intel.com/pressroom/archive/releases/20090109comp.htm>

## 2 WHAT ARE LOW-COST COMPUTING DEVICES?

To many researchers, academics, development specialists and government officials, a low-cost computing device is a specific concept, grounded in a philosophical context. The idea behind low-cost computing devices developed from then-MIT Lab researcher Nicholas Negroponte, who articulated a vision of an inexpensive laptop for every child in the world. A prototype of the computer was shown at the World Summit on the Information Society (WSIS) in 2005.<sup>2</sup> Describing the benefit of low-cost computing devices, former UN Secretary-General Kofi Anan said, "Children will be able to learn by doing, not just through instruction. They will be able to open up new fronts for their education, particularly peer-to-peer learning." He added that the idea was inspiring, with real potential for students' social and economic growth in developing countries.<sup>3</sup>

Policies for introducing computers in schools have traditionally revolved around "computer labs," with a number of students sharing one computer. The low-cost computer device movement is oriented towards each student having his or her own laptop. This *one-to-one* concept gives pupils more time on the computer than in a shared, lab-type environment. A calculation carried out for Nepal found that a computer lab user only spends one percent of the time that a student with a LCCD spends on the computer.<sup>4</sup>

Another model for reducing the cost of computers in schools is the "thin-client" approach, in which a simple computer (the "client") is connected to a server that carries out most of the processing. This is similar to the environment that existed in the pre-personal computer era, when terminals were connected to host computers. This model is attractive from a cost perspective, since thin clients are cheaper than conventional computers. It is also attractive for a school environment, where a teacher has more control over the computer learning environment. This solution has been used in rural schools in Brazil, where the cost per workstation is around USD 50.<sup>5</sup>

While one-to-one computing is attractive, it is an expensive proposition. Using the figures referred to earlier, the cost of outfitting 1.3 billion developing country students with their own laptops would be over USD 100 billion, assuming a USD 100 laptop and not considering all of the other associated costs such as transport, distribution, maintenance and training.

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<sup>2</sup> The unveiling occurred during the "Phase II" conference and trade show, held in Tunis, 16-18 November 2005.

<sup>3</sup> <http://news.bbc.co.uk/2/hi/technology/4445060.stm>

<sup>4</sup> <http://202.70.77.73/downloads/olpc-english.pdf>

<sup>5</sup> <http://www.desktoplinux.com/news/NS2824724304.html>

**Table 1: Pros and Cons of Computer Labs and One-to-One Computing**

Model	Pros	Cons
One computer per student (laptops)	<ul style="list-style-type: none"> <li>• Can be taken home and shared with family</li> <li>• Creates sense of ownership with less theft and damage</li> <li>• Some designed for developing country rural environment (e.g., handle extreme temperatures, low battery use, etc.)</li> <li>• Some designed for children (e.g., rugged, ergonomic)</li> <li>• Some include educational software and ecosystem of support</li> <li>• More democratic in that all children receive computers</li> </ul>	<ul style="list-style-type: none"> <li>• Relatively expensive</li> <li>• Can be disruptive</li> </ul>
Computer labs (recycled computers, thin clients)	<ul style="list-style-type: none"> <li>• Less disruptive than one-to-one model</li> <li>• Computer lab more economical than one-to-one</li> <li>• More practical for shared settings such as computer labs or community centres. Generally more powerful than laptops</li> </ul>	<ul style="list-style-type: none"> <li>• Higher maintenance and support since likely to be different computer brands</li> <li>• Students spend less time with computer</li> <li>• Labs may not be equitably distributed throughout school system or computers can be dominated by certain students</li> </ul>

The main commonalities of LCCDs, regardless of the brand or specific functionality, are a relatively low price (less than USD 300 for the device), laptop form factor and small size (e.g., screen size less than ten inches).

Leading examples of LCCDs include:

- XO – A laptop developed by OLPC, specifically designed for primary school students in developing nations with a range of features appropriate to that environment. The XO design has considered technological issues

such as local language support as well as environmental conditions such as high heat and humidity.”<sup>6</sup> In order to minimize malfunctions, it has no movable parts (e.g., no hard disk or fan) and features special antennas to support mesh networking.

- Classmate – A laptop developed by semiconductor manufacturer Intel as a “mobile personal learning device for primary students in emerging markets.”<sup>7</sup> Originally introduced in 2006, the second-generation Classmate is built around an Intel processor and has a rugged, “kid-friendly” design. Features include hardware-based theft protection,<sup>8</sup> Wi-Fi and a battery life of between 3.5 to 5 hours. The Classmate runs Windows XP or Linux and is available in clamshell or convertible designs. Intel has licensed the technology to various manufacturers.
- Encouraged by the LCCD movement for students, computer makers have been downsizing laptops to also tap into the market (e.g., netbooks). A noteworthy one in terms of price and entry into the educational market is the Asus Eee.<sup>9</sup> Asustek, a Taiwanese computer manufacturer, has developed rugged portable computers for use in space, off-car road races, Mount Everest and the North and South Poles.<sup>10</sup> It introduced the Eee PC (“Easy, Exciting and Economic”) notebook in October 2007. The Eee, like the XO and Classmate, is a portable laptop that uses flash drive storage, and the entry-level models are price competitive. But the Eee was not strictly designed for the educational environment like some of the other models. As with other commercial computers, it comes in a much wider range of configurations and models than the Classmate or XO.
- Another LCCD that may become the focus of greater attention is the Mobilis,<sup>11</sup> manufactured by the Indian company Encore. The Mobilis was recently selected in a tender for school laptops in Brazil.<sup>12</sup> Yet another is the Israeli-designed ITP-C, which is being used in school projects in Argentina and Chile.<sup>13</sup>

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<sup>6</sup> <http://laptop.org/en/laptop/hardware/index.shtml>

<sup>7</sup> <http://www.intel.com/intel/worldahead/pdf/CMPCbrochure.pdf>

<sup>8</sup> The theft protection links the Classmate to a school server. If the Classmate loses connection to the server for a certain period of time, it is rendered unusable and can only be reactivated if returned to the school. See: [http://blogs.intel.com/technology/2009/08/classmate\\_pc\\_as\\_a\\_one-to-one\\_1.php](http://blogs.intel.com/technology/2009/08/classmate_pc_as_a_one-to-one_1.php)

<sup>9</sup> For a comparison of different commercially available low-cost laptops see:

<http://blog.laptopmag.com/low-cost-laptop-cheat-sheet>






<sup>10</sup> [http://www.asus.com/ContentPage.aspx?Content\\_Type=AboutASUS&Content\\_Id=9](http://www.asus.com/ContentPage.aspx?Content_Type=AboutASUS&Content_Id=9)

<sup>11</sup> <http://www.ncoretech.com/products/ia/mobilis/index.html>

<sup>12</sup> <http://www.agenciabrasil.gov.br/noticias/2008/12/17/materia.2008-12-17.8621960410/view>

<sup>13</sup> <http://www.itp-c.info/>

**Figure 1: Low-Cost Computing Devices Used in Schools**

				
<b>OLPC XO</b>	<b>Intel Classmate</b>	<b>ASUS Eee</b>	<b>Encore Mobilis</b>	<b>ITP-C</b>
Afghanistan, Bhutan, Brazil, Cambodia, Colombia, Ghana, Guatemala, Haiti, India, Iraq, Lebanon, Mali, Mexico, Mongolia, Mozambique, Nepal, Nigeria, Niue, Pakistan, Papua New Guinea, Paraguay, Peru, Rwanda, Solomon Islands, South Africa, Thailand, Uruguay	Argentina, Brazil, Chile, China, Egypt, India, Indonesia, Lebanon, Libya, Malaysia, Mexico, Nigeria, Pakistan, Philippines, Russia, South Africa, Sri Lanka, Thailand, Uganda, Vietnam	Russia	Brazil	Argentina, Chile

*Note:* The list of countries where the devices are used in schools excludes developed nations.

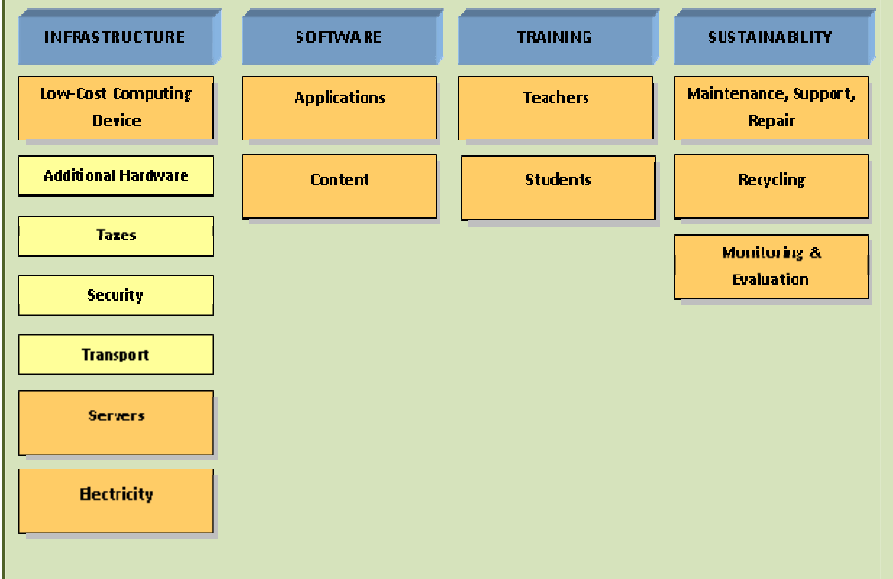
### 3 LOW-COST COMPUTING DEVICE COST ELEMENTS

There are a variety of direct and ancillary costs involved in the implementation of a low-cost computing program. The initial costs include the LCCD hardware, software licenses (if not included with the LCCD), as well as certain peripherals (printers, additional memory, etc.), network access, and development of content specifically for the LCCD program.

Other costs involve taxes, as well as the transport and distribution costs related to the deployment of the LCCDs. The size of the country can impact distribution and transport costs — e.g., a smaller, more urbanized, country will have lower transport costs than a large, dispersed one.

The training of children and teachers on the LCCD is another initial ancillary cost that must be included as a cost element. There are also a variety of ongoing costs related to an LCCD program. These include costs related to the maintenance of computers, software upgrades, security, ongoing network access costs, electricity, and staff costs, if applicable.

**Figure 2: LCCD Cost Elements**



The software that comes with the LCCD, along with government policies for applications and educational content, impacts software costs. Some countries may find that the applications that come with the LCCD are sufficient for their needs while others may want to use freely available applications that can be downloaded from the Internet or purchased commercially. In terms of educational content, there are hundreds of free packages. Content is already available in some countries that must be modified to run on the LCCDs, but brand-new content may need to be developed in other countries.

## Infrastructure

Infrastructure refers to the ICT hardware and other infrastructure components typically required for an LCCD program. Apart from the cost of the LCCD itself, other physical elements need to be factored into a LCCD program including peripheral components for the LCCD, networking, servers and electricity.

Although one of the goals of the one-to-one computing movement was a USD 100 laptop, this has yet to be achieved. LCCD costs vary depending on brand, configuration and the number purchased. The unit prices of various LCCDs are shown in the table below.

**Table 2: Unit Price of Various LCCDs**

Type of LCCD	Price (USD)	Remark
OLPC XO	199.99	Price for donating a new OLPC to a child in a developing country <sup>14</sup>
Classmate PC	205.00	Price on Amazon.com for following model: CTL E09XPH 9-Inch 2goPC Laptop (900 MHz Intel Celeron Processor, 512 MB RAM, 40 GB Hard Drive, XP Home)
ASUS Eee	299.99	Price on Google Product Search for following model: 7" Eee PC 4G 701 Notebook

All of the LCCDs described in Section 2 come with a number of features such as Wi-Fi network capability, integrated cameras and microphones, etc. and are ready to use as is. Additional components for the LCCDs would be a function of what each country deems necessary. These primarily revolve around storage, connectivity and peripherals.

<sup>14</sup> <http://laptop.org/en/participate/ways-to-give.shtml>

- *Storage:* Most LCCDs used for education come with flash drives rather than hard disks. The capacity of the drives varies. If the storage is deemed insufficient, then the cost of obtaining higher capacity flash drives would need to be factored into the unit cost.
- *Connectivity:* All of the LCCDs come with Wi-Fi connectivity. However, in order to connect to the Internet, access points need to be provided.
- *Peripherals:* Printers and scanners might also be needed.

## Taxes

Import duties, Value-Added Taxes (VAT) and other taxes add to the cost of a LCCD, as well as other supporting equipment. Policies vary widely regarding the extent to which these taxes are applied. Therefore, the impact of taxes on the LCCD program will vary from country to country. As noted, import duties are not an issue in countries that have abolished duties on information technology equipment. VAT also may not be applicable if the computers are shipped directly to the government instead of going through a third party.

## Security

Security costs must be contemplated to minimize the theft of the LCCDs. Both the XO and the Classmate have security features, reducing additional expenditures on security. The Classmate has built-in anti-theft features<sup>15</sup> while the XO uses software-based security.<sup>16</sup> While these systems will generally render the LCCD unusable for unauthorized users, they may not be sufficient to reduce physical thefts, particularly if the thief is not aware of these features. Having students take the LCCD home at night can reduce security costs. Conversely, a locked or guarded location to store the LCCDs should be considered.

## Transport

Transport can form a significant part of the costs. LCCDs need to be transported from the manufacturing location to the country. Each country's costs for distribution of LCCDs will vary tremendously depending on the distance from the LCCD manufacturing locations and the breadth of deployment, as well as the shipping method. Once in the country, the LCCDs then must be transported to different schools.

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<sup>15</sup> [http://www.classmatepc.com/pdf/CMPC\\_Product\\_Brief\\_Sec\\_Gen\\_Eng\\_HiRes.pdf](http://www.classmatepc.com/pdf/CMPC_Product_Brief_Sec_Gen_Eng_HiRes.pdf)

<sup>16</sup> [http://wiki.laptop.org/go/Bitfrost#Current\\_Status](http://wiki.laptop.org/go/Bitfrost#Current_Status)

## Adaptation for Persons with Disabilities

Since most LCCD projects are still pilots with few large-scale deployments, limited resources have been directed at making them usable for disabled children. Nonetheless, certain countries, such as Portugal, Russia and Uruguay, have introduced measures to make LCCDs accessible to disabled children. At this stage, it is too early to determine the costs of making the necessary adaptations in each country. However, various groups are doing work, which provides a forum for sharing experiences and potentially identifying ways to reduce costs.

## Servers

LCCD programs are significantly enhanced through the inclusion of computer servers. These computers are generally more powerful than the LCCDs and provide a range of services including Internet connectivity, printer sharing, file downloading and disk storage. Assuming such services are desirable, then the cost of the servers, peripheral devices such as printers, and networking costs must be factored into the LCCD project.

## Electricity

The availability of electrical power has a major impact on the scope of a LCCD program. Some form of electrical current is needed to recharge the LCCD devices and power servers for supporting the program. Power costs can be divided into three areas: 1) existing electricity at schools slated for LCCDs; 2) the charging aspects of the LCCD itself; and 3) on-going electrical costs. If electricity does not exist at the schools, the cost of providing some type of power to recharge LCCDs needs to be factored into the costs.

## Software

*Software* refers to the LCCD operating system and applications, as well as educational content. *Applications* refer to the computer operating system and programs such as word processors, spreadsheets, databases and Internet browsers. Basic applications are not necessarily a significant cost item depending on: (i) the type of LCCD; (ii) the operating system; and (iii) software applications desired. All low-cost computing devices come with some application software along with the operating system. Many software applications are available at no cost. For example, popular Internet browsers (e.g., Explorer, Firefox, Chrome, Opera, etc.) are free and run on different operating systems. In some countries, there are requirements that the LCCDs contain open software solutions due to the high cost of commercial applications.

Content covers educational materials developed for use on computers. Content specific to the educational system of each country where low-cost computing devices are used will have to be developed. The availability of free content can help to alleviate these costs.

## **Training**

Both teachers and students require training on how to use LCCDs. Beyond that, teachers will need to understand how to use LCCDs in the classroom environment. Training in basic maintenance and repair may also be necessary in order to keep LCCDs operational.

Teacher training involves a number of steps, which are generally sequenced. The initial group to receive LCCDs requires training in integrating the LCCD in the classroom environment and routine trouble shooting and maintenance. They, in turn, generally pass their experience on to the next group to receive LCCDs. Student training is typically not a cost item since it is part of the educational process. In other words, students learn how to use the LCCDs just as students would learn mathematics or science in class.

## **Maintenance**

LCCDs and other supporting equipment, such as servers and networking components, require maintenance and repair. In addition, support staff—which may require new personnel to be hired or contracted—need to receive LCCD maintenance training. The costs incurred depend on how the program is designed. Costs can be internalized if existing students and staff are trained in basic repair and maintenance and in turn, pass their knowledge on to others (“train the trainers”). Specialized staff will require training for more sophisticated repair activities.

## 4 IMPLEMENTING A SUSTAINABLE LOW-COST COMPUTING DEVICE PROGRAM

The implementation of a LCCD program is a complex undertaking. LCCDs have a significant impact on classrooms, teachers, training methods, distribution of educational materials and curriculum. They also affect school funding and infrastructure requirements (e.g., electricity and networking). Given the complexity of the program, impacts and requirements for a range of expertise, many countries have implemented LCCD projects with different partners.

Once the decision is made to implement a low-cost computing device program, it is generally coordinated through the country's educational ministry. Furthermore, partners often insist on some kind of commitment from the education ministry before they will participate. Although the education ministry may take overall responsibility for the program, ongoing management is sometimes delegated to a technical branch of the ministry or agency of the government.

### Funding

A full-scale, one-to-one LCCD program typically exceeds the resources of most developing nations. Take Nepal, where the government drastically raised the education budget with a planned expenditure of USD 688 million for the 2009/2010 school year.<sup>17</sup> Assuming a price of USD 150 for each LCCD, and with 4.4 million primary students, the cost of providing each with a LCCD would be USD 663 million --practically the entire education budget.

Most LCCD programs are conceived as public-private partnerships so that costs can be spread among various parties. In addition, some vendors sponsor initial donations of computers for pilot projects. Governments must cover some funding to demonstrate commitment and sustainability. The extent of the government's financial support depends on the scope of the program. A pilot in a few schools will not entail significant government resources, whereas a full-scale national implementation would do so.

The private sector has been active in some countries supporting low-cost computing device initiatives. Vendors such as OLPC and Intel have donated

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<sup>17</sup> [http://www.pustakalaya.org/eserv.php?pid=Pustakalaya:675&dsID=SSR\\_Plan\\_Oct\\_15\\_Draft\\_Despatch.pdf](http://www.pustakalaya.org/eserv.php?pid=Pustakalaya:675&dsID=SSR_Plan_Oct_15_Draft_Despatch.pdf)

LCCDs for numerous projects around the world. OLPC also has a facility on its web site allowing individuals to contribute money for donated computers.<sup>18</sup> A growing number of telecommunications firms are becoming active in low-cost computing programs. This has often leveraged their network experience, particularly in countries where Internet access has been part of the deployment.

NGOs are also supporting various LCCD programs. The Internet Society has provided funding for the evaluation of the LCCD project in the Solomon Islands.<sup>19</sup> In one of the world's largest non-governmental LCCD programs, the Volnoe Delo Educational Foundation is providing funding for implementing LCCDs in Russian schools.<sup>20</sup> Some multi-lateral and bi-lateral development agencies are playing a significant role in the LCCD movement. For example, the Inter-American Development Bank (IDB)<sup>21</sup> is providing funding support for LCCD pilots in Haiti<sup>22</sup> and Paraguay.<sup>23</sup>

One source of financing in some countries has been the contribution that telecommunications operators make to finance infrastructure development in underserved areas. These contributions, typically a proportion of the operator's revenue, are paid into a universal service fund that is generally administered by the country's telecommunication regulator. The funds have been used in several countries to finance the acquisition of computers for schools.

## Distribution

Under the one-to-one LCCD philosophy, each child has his or her own computer. In practice, however, this may be difficult for most developing nations, given the enormous expense of outfitting each child with a computer, particularly in countries with large populations of children. Most LCCD implementations are still pilot projects where benefits and viability are being tested before deciding on a more wide-scale distribution. One strategy would therefore be to test the LCCD under a number of different school environments such as urban and rural, public and private, younger and older students, etc. that are characteristic of the educational system of the country as a whole. Determining a representative sample size will influence the number of LCCDs that will be needed for a pilot to ensure a scientifically accurate evaluation

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<sup>18</sup> <http://laptop.org/en/participate/ways-to-give.shtml>

<sup>19</sup> [http://www.picisoc.org/tiki-read\\_article.php?articleId=45](http://www.picisoc.org/tiki-read_article.php?articleId=45)

<sup>20</sup> [http://www.basel.ru/en/media/news/2008/news\\_23\\_12\\_2008/](http://www.basel.ru/en/media/news/2008/news_23_12_2008/)

<sup>21</sup> <http://www.iadb.org/news/detail.cfm?language=English&ARTID=3668&ARTTYPE=pr&PARID=2&id=3668&CFID=1709965&CFTOKEN=51997935>

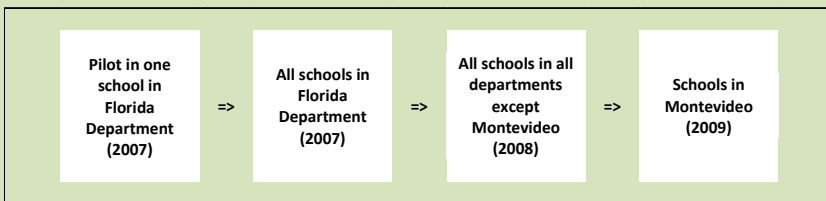
<sup>22</sup> <http://www.iadb.org/news/detail.cfm?artid=4413&language=En&id=4413&CFID=1280276&CFTOKEN=76605445>

<sup>23</sup> <http://www.iadb.org/Projects/project.cfm?id=PR-T1081&lang=en>

across a range of school environments.

Another distribution strategy is *saturation*. A smaller number of schools are selected, but students in all grades are provided with LCCDs. The benefit of this approach is that the pilot can be tested across a range of grades in one environment. This would require fewer LCCDs and minimize resentment among children that might arise if some students have LCCDs and others do not. One way of achieving saturation with wider school distribution is through *sharing*, particularly where schools are operated in shifts.

**Figure 3: Sequencing LCCD Distribution in Uruguay**



*Note:* Departments are the top level administrative unit in Uruguay equivalent to a province or state. There are 19 departments in Uruguay.

*Source:* Plan Ceibal.

If the decision is taken to scale-up the program to incorporate the whole country, a timetable will be needed since all the devices cannot be distributed at once. In Uruguay, LCCDs were distributed first to a school in a pilot school in one province, followed by all the schools in the same province, then to all schools nationwide except for the capital and finally the capital.

## Gender Issues

Explicit discrimination regarding gender has not been a significant issue in the on-going LCCD trials and implementations around the world. The concept of one-to-one computing is inherently more equitable than a shared environment, in which some students could come to dominate the limited number of computers. LCCDs also have the potential to train mothers when students are allowed to bring them home. OLPC has found this has a great influence on the family, with children teaching mothers and even grandmothers computer skills. For this reason, OLPC often insists that governments let children take the LCCDs home.

## 5 NATIONAL CASE STUDIES

There are several excellent examples of LCCD distribution projects in developing and developed countries:

- **Afghanistan** – In September 2008, the Ministry of Education (MoE) and Ministry of Communication and Information Technology (MoCIT) launched an OLPC pilot in Afghanistan.<sup>24</sup> The project is a public-private partnership with the United States Agency for International Development (USAID), Roshan, a mobile operator in Afghanistan, and Paiwastoon, a local information technology company.
- **Brazil** – The government announced its One Computer per Student (*Um Computador por Aluno*) project in 2005. The project is coordinated by the President’s office and implemented by the Ministry of Education. It has also been integrated into the country’s educational development program.
- **Peru** – In May 2007, the Minister of Education announced the country’s participation in OLPC,<sup>25</sup> stating that every school child would receive a laptop. The goal is to provide all primary school students with a laptop by 2011.<sup>26</sup> By mid-2008 some 40,000 computers had been distributed, with another 100,000 installed by the end of the year and plans to purchase an additional 150,000 in 2009.<sup>27</sup>
- **Portugal** – The “e-escola” program was announced in June 2007. This program calls for distributing 750,000 laptops (ASUS, ACER, Fujitsu, HP, Insys or Toshiba) with a broadband subscription by 2010 to teachers and secondary students.
- **Rwanda** – Rwanda launched its OLPC program in October 2008, with three schools receiving 5,000 laptops and another 10,000 distributed to schools in five districts in 2009. The program calls for an additional 100,000 XO laptops to be provided to at least half the primary schools in the country by 2012.<sup>28</sup>
- **Uruguay** – President Tabaré Vázquez announced the Ceibal Project in December 2006 with the aim of providing each child with a laptop by 2009. There are 360,000 primary students in the country. The government is funding the project through an increase in education funding.

<sup>24</sup> <http://moe.gov.af/news/Sanbullah/15September2008.htm>

<sup>25</sup> [http://www.larepublica.com.pe/component/option,com\\_contentant/task,view/id,155810/Itemid,0/](http://www.larepublica.com.pe/component/option,com_contentant/task,view/id,155810/Itemid,0/)

<sup>26</sup> <http://www.minedu.gob.pe/noticias/index.php?id=6432>

<sup>27</sup> <http://www.livinginperu.com/news/7566>

<sup>28</sup> <http://allafrica.com/stories/200901080184.html>

## 6 CONCLUSIONS

The full module on LCCDs examines various issues that should be considered in implementing LCCDs for schools. It has presented a variety of country experiences. Based on the analysis, several conclusions can be drawn:

- The selection of a particular LCCD depends on a country's educational strategy and development status.
- The selection of a particular LCCD is also dependent on the pedagogical orientation of a country, government software policies and the age of the school children.
- The immediate introduction of a one-to-one computing model is beyond the financial capability of most developing countries. Therefore, countries need to consider a phased approach involving a mixture of computer labs and individual computers.
- Objective studies about the costs and benefits of education-oriented laptops, commercially available laptops, recycled computers and thin-clients are still lacking.
- There must be a long-term commitment to one-to-one computing and LCCDs. Each year, new students enroll and will also need an LCCD. Governments need to ensure on-going funding and sustainability for this.
- Another financial challenge for developing countries is the need to balance the introduction of broadband Internet connectivity in schools with promoting one-to-one computing. The goals of one-to-one computing and broadband connectivity are both important, but with limited budgets, governments need to balance priorities.





